Abstract

Despite many advances in the design methods for compliant mechanisms, it is still not possible to know if a set of user-specifications has a solution. Furthermore, practical considerations such as failure limits and manufacturing limitations cannot be easily incorporated into existing methods. To address these issues, we have recently developed the concept of feasible stiffness and inertia maps. This thesis extends the concept of feasible maps and proposes another kind of maps that comprehensively depict the nonlinear kinetoelastostatic behaviour of compliant mechanisms.

Feasible maps drawn as per user-specifications, with compliant mechanisms of the database overlaid on it, instantly inform the reader whether the specifications are feasible; whether the specifications are stringent; whether any mechanisms in the database meet the specifications, and whether any mechanism can be interactively modified to meet the specifications including size, strength and manufacturability. This thesis extends the earlier work on feasible maps by relaxing one condition that all beam segments in a compliant mechanism must retain their relative proportions. This is achieved by using size optimization. Thus, a certain degree of automation is brought into the procedure, which enhances the ease of use of the feasible maps. Illustrative examples are presented and implementation into a software is demonstrated.

A major contribution of this work is the development of the concept of kinetoelastostatic maps of compliant mechanisms with fixed topology, shape, and relative proportions of beam segments in them. The map is drawn on a 2D plot using two non-dimensional quantities, one that captures the response of the mechanism and the other that combines the force, geometry, and material parameters. The map encloses a region that indicates the *kinetoelastostatic* capability of the mechanism. Another contribution of this work is the observation that the enclosed region can be parameterized using average slenderness ratio of the beam segments. The resulting curves help designers in assessing the capability and limits of a mechanism in terms of geometric advantage, mechanical advantage, normalized output displacement, inherent stiffness, etc. Numerous examples are presented to explain various uses of the non-dimensional maps.